

LIBRARY
UNIVERSITY
OF CALIFORNIA

CALIFORNIA

STATE BOARD OF HORTICULTURE.

DIVISION OF ENTOMOLOGY.

DESTRUCTIVE INSECTS,

Their Natural Enemies, Remedies and
Recommendations.

P. 1656

BY ALEXANDER CRAW,

Quarantine Officer and Entomologist.



SACRAMENTO:

STATE OFFICE, : : : : : A. J. JOHNSTON, SUPT. STATE PRINTING.

1891.

CALIFORNIA

STATE BOARD OF HORTICULTURE.

DIVISION OF ENTOMOLOGY.

DESTRUCTIVE INSECTS,

Their Natural Enemies, Remedies and
Recommendations.

BY ALEXANDER CRAW,

Quarantine Officer and Entomologist.



SACRAMENTO:

STATE OFFICE, : : : : A. J. JOHNSTON, SUPT. STATE PRINTING.

1891.

NOV. 17 1903
In Ench.
Stan. Uni.

SB824
CA 12

STATE BOARD OF HORTICULTURE.

OFFICERS AND MEMBERS.

- ELLWOOD COOPER, President.....Santa Barbara,
Commissioner for the Los Angeles District.
- L. W. BUCK, Vice-President.....Vacaville,
Commissioner for the Napa District.
- S. RUNYON, Treasurer.....Courtland,
Commissioner for the Sacramento District.
- J. L. MOSHER, Auditor.....San Francisco,
Commissioner for the State at Large.
- FRANK A. KIMBALL.....National City,
Commissioner for the State at Large.
- A. F. WHITE.....Santa Rosa,
Commissioner for the Sonoma District.
- FRED. C. MILES.....Penryn,
Commissioner for the El Dorado District.
- I. H. THOMAS.....Visalia,
Commissioner for the San Joaquin District.
- A. BLOCK.....Santa Clara,
Commissioner for the San Francisco District.
- B. M. LELONG, Secretary.....Ex officio Chief Horticultural Officer.
- ALEXANDER CRAW.....Quarantine Officer and Entomologist.
- ELLA F. HALLAHAN.....Clerk.

Office of the Board:
No. 220 SUTTER STREET, SAN FRANCISCO.

FRANK A. KIMBALL
220 SUTTER STREET

CONTENTS.

I.	
Coccidæ	6
II.	
Scale Insects	7
III.	
Miscellaneous Insects	17
IV.	
Beneficial Insects	25
V.	
Internal Parasites	27
VI.	
Remedies	30
VII.	
Spraying Apparatus	37

LETTER OF TRANSMITTAL.

SAN FRANCISCO, October 10, 1891.

Mr. B. M. LELONG, Secretary State Board of Horticulture:

DEAR SIR: I herewith submit this brief report upon destructive insects, their natural enemies and remedies, including the mechanical appliances used in this State for the suppression of the former.

I beg to acknowledge the assistance of Mr. Edward M. Ehrhorn, of Mountain View, who, during my absence in the southern part of the State, acted as my deputy and inspected all steamers arriving at this port from foreign countries.

Respectfully,

ALEXANDER CRAW,
State Quarantine Officer and Entomologist.

I.

COCCIDÆ.

The most formidable of all insects that infest fruit trees in this State are those of the family Coccidæ. They are also more easily transported, as they are firmly attached to the bark of trees or plants, and multiply and spread to adjoining orchards. This has been the experience with all the destructive species now found in California, none of which are natives of the State. *Lecanium oleæ*, for instance, is a native of Europe; *Icerya purchasi* and *Aonidia aurantii*, of Australia; *Aspidiotus citrinus*, of Japan. *Aspidiotus perniciosus* is also undoubtedly of foreign origin. Some of these species can now be found upon indigenous trees and plants of the State, and far away from orchards or cultivated trees, carried thence in the larval state by the wind, birds, bees, or other insects that visit infested trees. We have accounts of others that are very destructive in different parts of the world, and would prove equally injurious here if they obtained a foothold in our salubrious climate.

The characteristic differences of the species that have made their presence felt in various sections, and others that have been found upon trees imported into our State from other States and foreign countries, are illustrated in colors, to give a better idea than a written description can convey. The species shown upon the wood and leaves are true to nature; those enlarged are as they appear when viewed through the microscope.

The new beginner in fruit culture may look with indifference upon such a small speck, and be inclined to pass it by, thinking it incapable of any serious damage. The time for effective work is when they are first discovered and before they have had an opportunity to make their baneful and blighting presence felt. First, a few spotted leaves and fruit; afterwards, the dropping of both; and finally, the dying and dead branches will be the result of delay.

II.

SCALE INSECTS.

DESCRIPTION, HISTORY, AND REMEDIES FOR THEIR DESTRUCTION.

OYSTER-SHELL SCALE.

Mytilaspis pomorum, Bouché.

[Colored plate, Figs. 1 and 2.]

This scale is very damaging to apple trees, and also infests other plants. The scale of the female is mussel shape, more or less curved, of a purplish brown color, with the exuviae yellowish. Length, one sixteenth of an inch. The body of the female is light yellow. The last segment presents the following characteristics: The anterior group of spinnerets consists of from eleven to seventeen; the anterior laterals and posterior laterals each of sixteen to twenty-one. The median lobes are large and wide, with the sides parallel; they are only about three fourths as long as broad. Each lobe is narrowed on each side near the distal extremity by one or two notches, and then rounded. The second lobe of each side is about as wide as the first, and is deeply incised; mesal lobule with mesal margin as long as lateral margin of the first lobe, and rounded posteriorly; lateral lobule about half the length and width of mesal lobule, and similar in shape. Third lobule obsolete. The plates are long, simple, and tapering.

Eggs.—These are white, and are arranged irregularly under the scale.

Scale of Male.—The scale of the male of this species is usually straight and of the same color as that of the female. At about one quarter of the length of the scale from the posterior extremity, the scale is thin, forming a hinge which allows the posterior part of it to be lifted by the male as he emerges. Length, .06 of an inch. The male is translucent, corneous gray, with a dorsal transverse band on each joint, and the portions of the mesothorax and metathorax darker, or purple gray, with the members somewhat lighter.

According to climate and locality the young scale hatch from the middle of March to June. Color, yellow. They begin to form the cottony excretion after twenty-four hours, and in two to four days the insect is completely covered with a dense excretion, which increases as the larva grows.

In several of the older apple-growing districts of the State this scale has secured a lodgment, and in neglected orchards that have been subdivided into city lots they have made considerable progress.

PURPLE SCALE.

Mytilaspis citricola, Packard.

[Colored plate, Figs. 3 and 4.]

This species can be very easily confounded with *Mytilaspis pomorum*, being very much like it in shape, but it is only found on citrus trees.

The scale of the female is long, slightly curved, and widened posteriorly. It is brown, with a purple tinge; the exuviae brown, with delicate margin. Ventral scale is well developed and of a dirty white color. It is a single piece attached to the lower edge of the scale, and is more or less incomplete posteriorly. Length of scale, .12 of an inch. The color of the female is pale yellow.

Eggs.—The eggs are white and placed irregularly under the scale.

Male.—The scale of the male is usually straight; of the same color as that of the female, sometimes almost black; the larval skin light yellow. For about one quarter of the length from the posterior end the scale is thin, forming a hinge which allows the posterior part of it to be lifted when the male emerges. Length, .06 of an inch.

This is a very serious pest in the orange groves of Florida, infesting the wood, leaves, and fruit. Young citrus trees imported from Florida infested with this scale and planted in the interior valleys of the State, have generally been found free from the pest after the first summer, but in the moist sections near the coast I am satisfied that they will thrive. My attention was recently called to trees that had been planted two seasons upon which the purple scales had bred, and spread to the young wood and foliage. The owner would take no risks with fumigation or sprays, so he cut the infested trees down. Similar results were noticeable with small trees infested with black scale (*L. oleæ*) and taken inland, but since the trees have developed large tops and more shade, it has been found necessary to spray in some of those districts, in order to have clean fruit.

The cargo of three hundred and twenty-five thousand Tahiti orange trees quarantined at the port of San Pedro for the past three months was seriously infested with the purple scale. This shows its wide distribution, as it is also found in the West Indies and in Europe.

LONG SCALE.

Mytilaspis gloverii, Packard.

[Colored plate, Figs. 7 and 8.]

This species resembles the purple scale, but differs in being straighter and much narrower, and in color it is yellow to dark brown. The ventral scale is white, very thin, and split longitudinally, showing the eggs arranged in two layers. In this characteristic it differs from the purple, and can be readily distinguished from the latter. The body of the female is light purple in color, with the last segment yellowish. The eggs are white when first laid, but become tinged with purple before hatching.

The male scale is similar in form to that of the female, but smaller and very seldom curved.

This scale was introduced into Florida in 1840 on trees imported from Bermuda, and fifteen years later they had spread to all the groves then existing in that State, destroying the tops and branches of the trees, and brought ruin to the orange growers. This condition of affairs continued for a number of years before the appearance of internal parasites that checked to a certain extent their ravages. This scale is also widely distributed; it is a common pest in the orange-growing sections of Europe. The past season I have destroyed two lots of orange trees infested with them that arrived here from Japan. Growers having trees imported from Japan should carefully examine them, and if found prompt measures should be taken to eradicate it before it attains a foothold in the orchard or on adjacent trees.

PERNICIOUS SCALE.

Aspidiotus perniciosus; Comstock.

[Colored plate, Figs. 5 and 6.]

This insect is of a grayish color except the center, which is of a pale yellow or sometimes reddish yellow. It is circular and flat, with the exuviae nearly central. Diameter, .08 of an inch.

The body of the female is yellowish, and almost circular in outline; segmentation is distinct; the last segment has the following characteristics: Two pairs of lobes are visible; the first pair converge at tip, are notched about midway their length on the lateral margin, and often bear a slight notch on the mesal margin near the tip. The second pair are notched once on the lateral margin. The margin of the ventral surface of the segment is deeply incised twice on each side of the meson, once between the bases of the first and second lobes, and again lateral of the second lobe. On each side of each of these incisions is a club-shaped thickening of the body wall. There are two inconspicuous simple plates between the median lobes, and on each side two similar plates extending caudad of the first incision; three small plates serrate on their lateral margin caudad of the second incision, and the club-shaped thickening of the body wall bounding it, and three wide prolongations of the margin between the third and fourth spines. These prolongations are usually fringed on their distal margin. There are also some irregular prolongations of the margin between the fourth spine and the penultimate segment. The first and second spines are situated lateral of the first and second lobes, respectively, the third spine lateral of the second incision, and the fourth spine about half the distance from the first lobe to the penultimate segment. The eggs are white.

Scale of Male.—The scale of the male is dark, and is somewhat elongated when fully formed. The larval skin is covered with secretion; its position is marked by a nipple-like prominence, which is between the center and the anterior margin of the scale.

Insect Enemies.—The parasitic and predaceous insects that feed upon this scale are: A small internal chalcid (*Aphelinus fuscipennis*) and the twice-stabbed ladybird (*Chilocorus bifulvus*). Several orchards in Santa Clara and Tulare Counties have been reported cleaned of scales by them.

YELLOW SCALE OF THE ORANGE.

Aspidiotus citrinus, Coquillett.

[Colored plate, Figs. 9 and 10.]

This species differs but slightly from *A. aurantii*, but in its habits and color there is a very marked difference. The female scale is circular, with the exuviae slightly to one side; the scale is not as convex; the margins are wider and a light gray. The body is a pale yellow; the ventral scale is light colored and remains attached to the upper one, making it difficult to remove the insect from the scale.

A curious fact about this insect is that it seldom attacks the wood, even when the foliage and fruit are covered with them. On this account the fruit grower can readily determine between it and *Aurantii*, as the latter infests the young shoots and even the large branches. When first introduced into this State in 1872, and for a number of years after, this proved to be a very destructive scale; but since then we have had the good fortune of having introduced its natural enemy—probably from Japan—a very small chalcid fly. This is a Japanese species, and this year I obtained a few specimens from an orange tree that had just then arrived from Japan, and from them hatched the same parasite that we find preying upon this scale in the San Gabriel Valley. This establishes the fact of our having the true parasite of this species.

FLORIDA RED SCALE.

Aspidiotus ficus, Ashmead.

[Colored plate, Figs. 13 and 14.]

This is a dark red scale, infesting citrus trees in Florida, settling on the wood, leaves, and fruit. The scale of the female is circular, with the exuviae nearly central. The position of the first skin is indicated by a nipple-like prominence, which, in fresh specimens, is white, and is the remains of a mass of cottony excretions, beneath which the first skin is shed. The part covering the second skin is light red, and the remainder is much darker, ranging from dark reddish brown to black; the thin part of the margin is gray. When full grown it measures .08 of an inch in diameter. The body of the female is nearly circular, and the color is white, with yellowish spots. The eggs are pale yellow.

The scale of the male is much smaller than that of the female; the posterior side is prolonged into a thin flap, which is gray in color.

Male.—The male is light orange-yellow in color, resembling the male of *A. aurantii*, but being smaller, having shorter antennæ.

Citrus trees imported from Florida should be carefully examined for this and other species that infest the trees of that State. From its dark-colored scale, it disfigures the fruit even more than *A. aurantii*, and its effect upon the tree is equally damaging. Upon a shipment of plants (*Ilex latifolia*) from Japan, I found a few specimens of this scale, which, after the second disinfection, were destroyed, and none have appeared since.

THE GLOOMY SCALE.

Aspidiotus tenebricosus, Comstock.

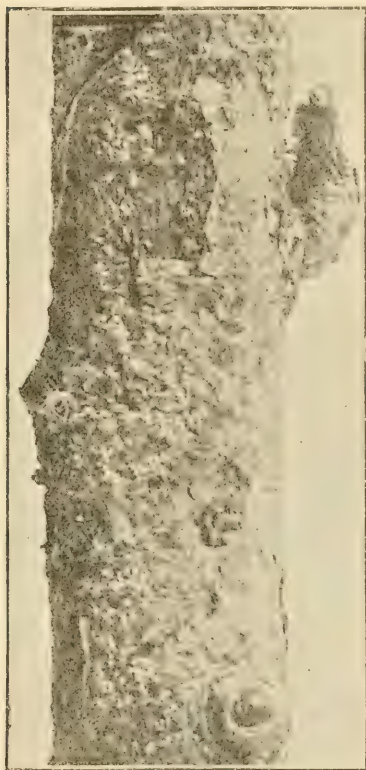


Fig. 19.

Scale of the female is dark gray. The protuberance indicating the position of the exuviae is marked with a white dot and concentric ring. In rubbed specimens this protuberance is smooth and black; in all cases the remainder of the surface of the scale is rough. The scale is convex; the exuviae is usually between the center and one side. The ventral scale is well developed, especially at the margin, where it is much thickened and is dark colored. The central part is white and adheres to the bark, while the thickened part is easily removed as a ring. Diameter of the scale, .06 of an inch. Female is nearly circular, being but slightly longer than broad, and is of a yellowish-brown color.

Scale of the male is oval in outline and of the same color as that of the female. The protuberance covering the larval skin is near the anterior end.

In the spring of this year I received specimens of this scale from San José. I afterwards visited that section and examined the few old apple trees that are infested with it. I observed that it only attacks the under side of the branches that measure one inch in diameter and over, giving the bark a rough, scaly appearance. It has not the poisonous effect upon

the wood, discoloring the inner bark and cambium layer, noticeable upon trees attacked by the pernicious scale. It appears to spread very slowly, as younger trees adjoining were not infested.

RED SCALE OF THE ORANGE.

Aonidia aurantii*, Maskell.

[Colored plate, Figs. 15 and 16.]

This is a circular scale, commonly known as the red scale, infesting citrus trees. This species resembles *Aspidiotus ficus* in shape, size, and the nipple-like prominence. The color varies from light greenish yellow to reddish brown. The central third is as dark, and usually darker, than the remainder of the scale, and when the female is fully grown the peculiar reniform body is discernible through the scale, causing the darker part of the outer two thirds of the scale to appear as a broken ring. The female is light yellow in color in the adolescent stages, becoming brownish as it reaches maturity. When fully developed the thorax extends backwards in a large rounded lobe on each side, projecting beyond the extremity of the abdomen and giving the body a reniform shape.

The scale of the male is smaller than that of the female, and the posterior side is prolonged into a thin flap. The part which covers the larval skin is often lighter than the remainder of the scale. The male is light yellow, with the thoracic band brown, and eyes purplish black.

Eggs.—These have never been seen excepting in the female's body, but larvæ having been found under the scale, it is supposed that the female is viviparous.

APRICOT SCALE.

Lecanium armeniacum, Craw.

[Colored plate, Figs. 11 and 12.]

Adult Female.—Color, light brown. In shape resembles *L. hesperidum*, but is much larger and more convex. In the center of the dorsum is a prominent shining circular protuberance, from which radiate a number of small ridges; these are more noticeable upon the posterior half of the scale. From the convex center to the anus is a low carina, also noticeable in front.

Length, from .20 to .27 of an inch; width, from .12 to .15 of an inch; height, from .05 to .10 of an inch. Antennæ tapering to the point, seven-jointed; joints 1 and 3 subequal; joint 2 nearly three times as long as joint 1; joint 4 slightly longer than joints 5 and 6; joint 7 is nearly same as joint 3, and tapers to a point; a few bristles at the tip and upon each joint.

Eggs.—These are smaller and lighter colored than *L. oleæ*.

Larvæ.—Are long, oval, light yellow, darker down the center, and can be distinguished from the larvæ of *Oleæ* in not having the four reddish brown marks upon the dorsum.

Like other species of *Lecanium* that produce but one generation a

* Formerly described as an "*Aspidiotus*."

year, their development is slow. They generally hatch in June and locate upon the leaves, where they go through their molt, and then move to the young wood. In the spring they grow rapidly and throw off great quantities of excrement, into which the spores of the black smut (*Fumago salicina*) adhere and grow, injuring the health of the tree and the market value of the fruit. The apricot, prune, and plum are its favorite food trees, but it also attacks the cherry, and slightly the pear.

FROSTED SCALE.

Lecanium pruinorum, Coquillett.

Description.—Adult female, pale brownish, thinly covered with a whitish powder, which does not conceal the ground color. Body oblong in outline, very convex above, not distinctly carinate, the surface very uneven. Margins nearly perpendicular; dimensions as follows: Largest specimens, length, .28 of an inch; width, a trifle over .20 of an inch; height, .12 of an inch. Smallest full-grown specimen, length, .16 of an inch; width, .12 of an inch; height, .08 of an inch. Antennæ much thickest at the base, 7-jointed; joint 6 the shortest, then 5, then 1 and 2, which are subequal in length; joints 3, 4, and 7 are also subequal in length, each nearly twice as long as 6; joint 7 tapers to the tip, and is furnished with a style, being about three fourths as long as this joint; anal cleft and lobes normal. The eggs are of the usual ovoid form of the *Lecaniums*, and of a yellowish white color, and are laid in May, June, and July.

Larvæ.—A few weeks after the eggs are deposited, the larvæ hatch out from under the old scale; they are of a pale color, having a distinct dorsal ridge extending the entire length of the body, and with many smaller ones (about twenty-four on each side) extending from it to the margin, some of them being divided into two branches.

Habit.—The larvæ as soon as hatched locate upon the leaves; their development is slow until they take up their position upon the under side of the young shoots, where they remain throughout the winter, and, in fact, the balance of their lives. Upon the ascent of the sap in the spring they grow rapidly, and in April they assume the characteristic powdery or frosted appearance peculiar to this species.

The first I observed of this species was upon apricot trees in the neighborhood of Los Angeles in the summer of 1887. Prof. J. Henry Comstock, to whom I forwarded specimens for determination, replied that the species was new, and gave it the manuscript name of *Lecanium pruinorum*. This scale prefers the apricot and peach, but I have also found them upon prunes, plums, pears, apples, and oranges, also upon several deciduous ornamental trees. The present season I have found a few specimens in Alameda and Santa Clara Counties.

Insect Enemies.—The only natural enemies I have found attacking the young of this scale are several species of ladybirds and the larvæ of the golden-eyed lace-wing fly.

MINING SCALE.

Chionaspis biclavis, Comstock.

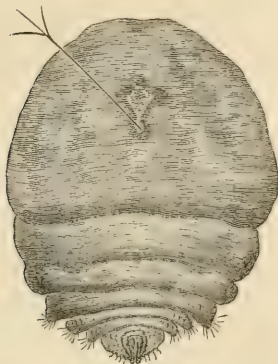


Fig. 20.

The recently quarantined orange trees at San Pedro, from Tahiti, were badly infested with this scale. The peculiarity of this species is in the fact that it burrows under the very thin skin that overlies the bark of orange trees. The bark covering the scale retains all its char-

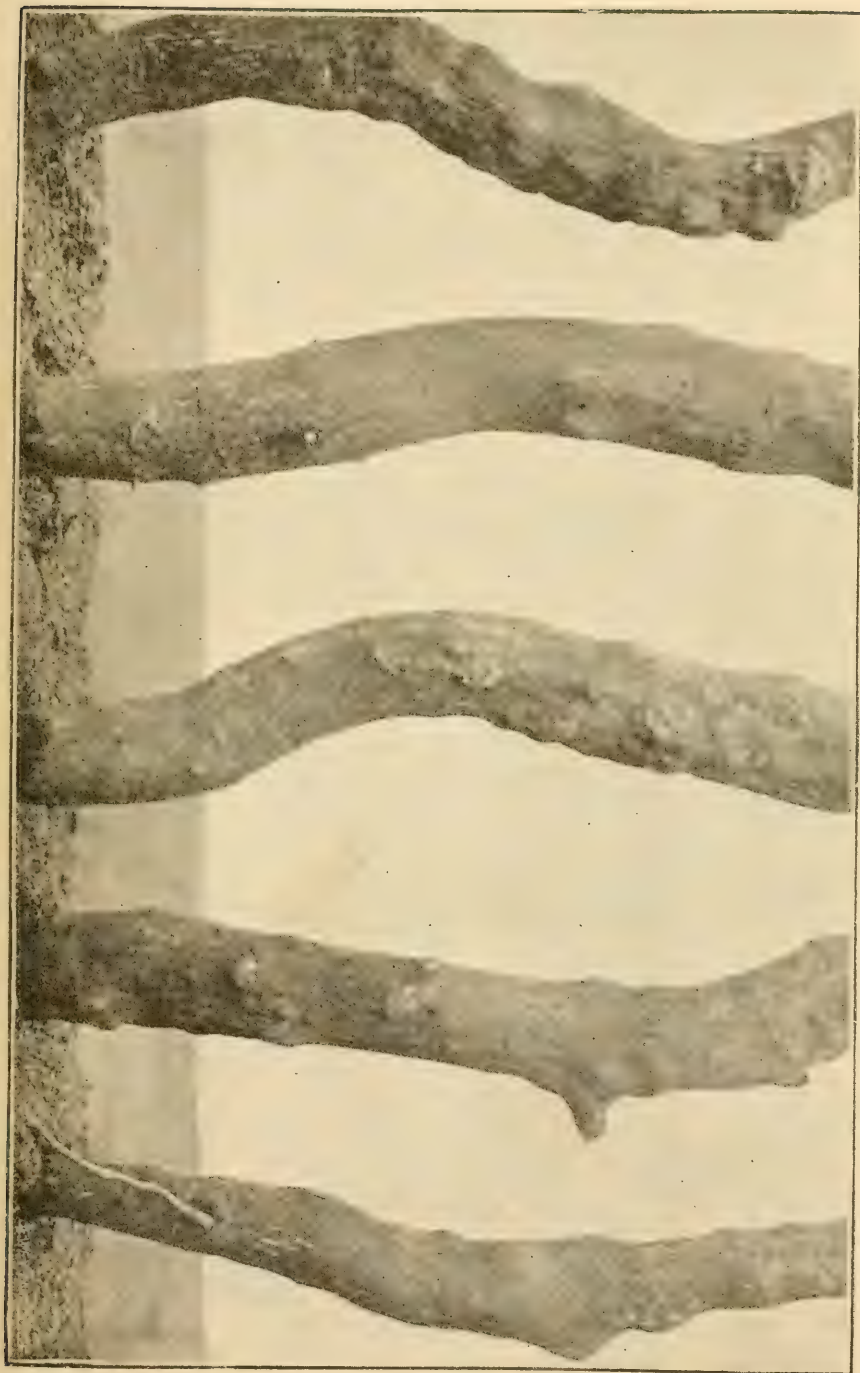


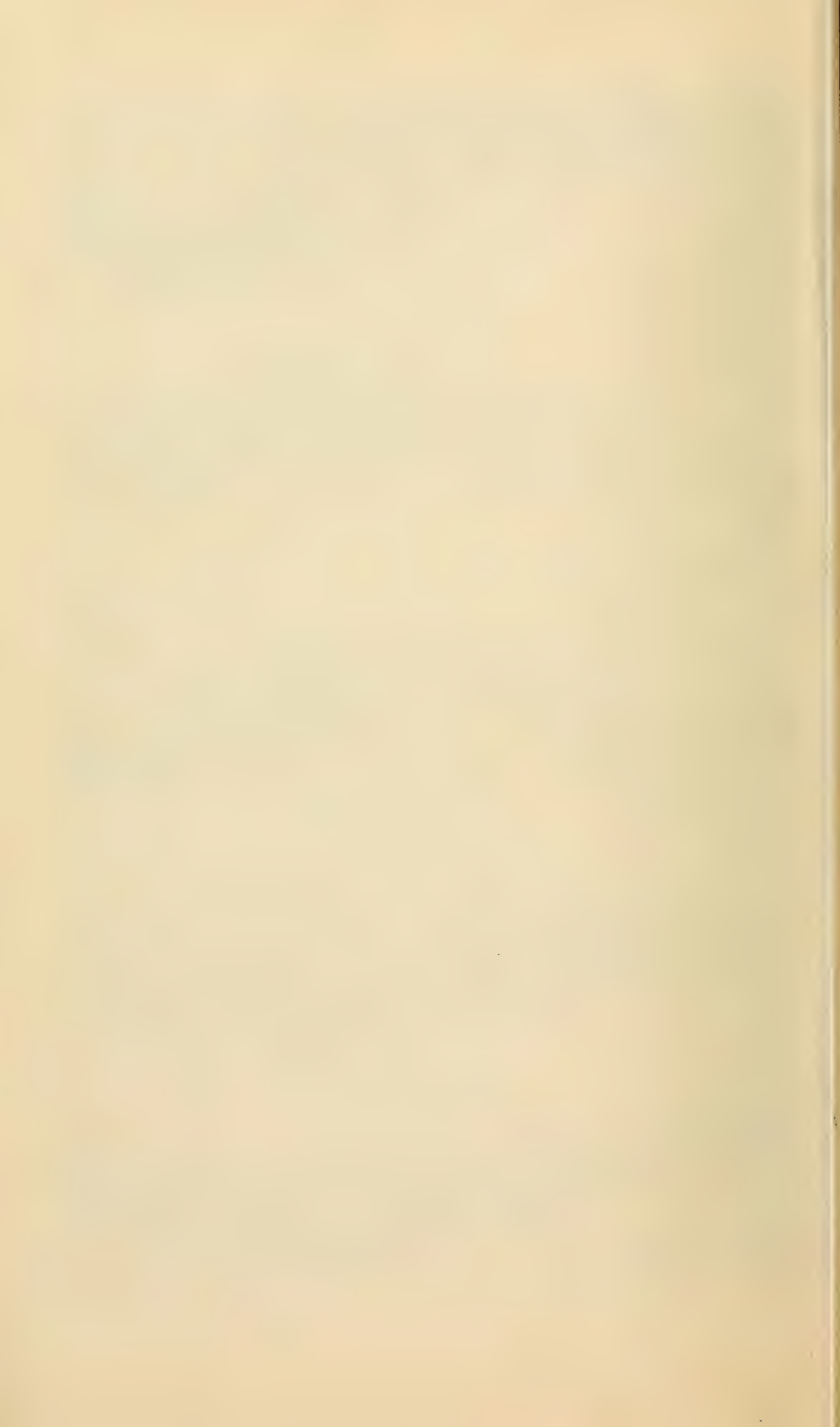
Fig. 21.

acteristic color and markings, and upon this account is liable to be overlooked but for the gnarled, warty swellings upon the trunks and branches produced by their attacks, a good idea of which can be had by reference to the illustrations.

I consider this scale one of the most dangerous that has ever come

SPECIMENS OF TREES THAT ARRIVED FROM TAHITI INFECTED WITH MINING SCALES.





under my notice, from the fact that it survived five treatments with hydrocyanic acid gas, with extra amounts of chemicals. All the other species upon the trees succumbed but this, and we found enough alive to justify the commencement of proceedings to have the cargo of three hundred and twenty-five thousand trees destroyed.

The body of the female, before reaching maturity, is translucent, afterwards changing to purple. The scale is light colored under the layer of bark, and when it is removed the thin, light-colored ventral scale remains attached to the bark, thus exposing to view the body of the insect (Fig. 20), which can easily be taken from the dorsal scale for examination.

LEMON SCALE.

Aspidiotus limonii, Signoret.

This species differs from *Aspidiotus nerii* by the caudal lobes being more detached and more apparent, and by the plates being larger, and more particularly by the more elongated form of the last abdominal segment. The scale of the female is circular, yellowish white, with exuviae central and yellow; that of the male is more elongated.

CHAFF SCALE.

Parlatoria proteus, Curtis.

Scale of female is elongate, more or less oval, of a transparent brownish yellow color, and whitish near the border. The exuviae are rounded oval in form, and are equal to about three sevenths of the length of the fully formed scale. The scale of the male is light brown, with the exuviae black.

EXPLANATION OF COLORED PLATE.

- Figs. 1, 2. Oyster-shell scale (*Mytilaspis pomorum*, Bouché).
Figs. 3, 4. Purple scale (*Mytilaspis citricola*, Packard).
Figs. 5, 6. San José scale, so called (*Aspidiotus perniciosus*, Comstock).
Figs. 7, 8. Long scale (*Mytilaspis gloverii*, Packard).
Figs. 9, 10. Yellow scale of the orange (*Aspidiotus citrinus*, Coquillett).
Figs. 11, 12. Apricot scale (*Lecanium armeniacum*, Craw).
Figs. 13, 14. Florida red scale (*Aspidiotus ficus*, Ashmead).
Figs. 15, 16. Red scale of the orange (*Aonidia aurantii*, Maskell).
Fig. 17. *Anatis subvittata*; natural size.
Fig. 18. *Exochomus marginipennis*; natural size.



BENEFICIAL AND INJURIOUS INSECTS.

III.

MISCELLANEOUS INSECTS.

GRAPE LEAF BEETLE.

Adoxus vitis, Fabr.



Fig. 22.



Fig. 23.

I received specimens of this destructive beetle in May last from Horticultural Commissioner William H. Robinson, of Stockton; also grape leaves showing the result of their work, an illustration of which is herewith appended. I afterwards received specimens from other grape-growing districts, which prove it to be widely distributed.

They are nearly one quarter of an inch in length; some specimens are black, others reddish brown. The base of the antennæ and the tibiæ are reddish. They attack the leaf, cutting long, narrow slits, and where very numerous will kill young vines, unless they are checked in their depredations. As soon as they make their appearance in the spring the vines, if not in bearing, should be thoroughly sprayed with Paris green, one pound to two hundred gallons of water. Moisten the Paris green with a little water, and when placed in the tank keep it constantly stirred while spraying. Use the old style Cyclone nozzle. They drop as soon as they are disturbed, and in this way they can be captured upon bearing vines by spreading a sheet under them and shaking them off, when they can be destroyed by burning in a portable fire. This work should be done in the morning, when they are sluggish.

BLACK APHIS OF THE PEACH.

Aphis persica-niger, Smith.



Fig. 24.

The danger of importing eastern nursery stock is not altogether confined to the Yellows or borers, but the black peach aphid is to be dreaded upon the peach as much as the woolly aphid upon the apple. Dr. Smith, who described this insect, says:

In Delaware, Maryland, and parts of New Jersey and Virginia this aphid was reported everywhere to be unusually prevalent and destructive. In April, when the leaf buds were pushing, I saw them clustered upon so many shoot axes and so compactly as to kill young trees, and even very considerable branches upon older trees. They were especially destructive to nursery trees and to orchards just planted. I saw one nursery in which at least one hundred thousand trees had been killed outright in two or three weeks' time. I also heard of half a dozen nurseries which were entirely destroyed or very seriously affected, and of orchardists who will be compelled to replant hundreds of trees. Such trees are badly dwarfed, and make only a feeble, sickly growth. The leaves are light green or yellowish, more or less rolled at the margins, and red or purple spotted from the attack of fungi.

It will be seen from the foregoing that this is a very serious pest, and eastern-grown trees should not be planted till properly disinfected; or, to be safe, the practice of planting eastern-grown trees ought to be discontinued.

The description of the species is herewith given, so that it can be identified. The winged form is well represented in the figure, so far as shape and general appearance are concerned. It is of a shining black or very dark brown color. The legs are deep brown on the thighs, the tips of the shanks, and the tarsi, else yellowish. The cornicles, or horny tubes, are quite long, moderately slender, and of the same color as the body. There is a series of deep pits on each side of the abdomen.

The wingless form differs in the somewhat stouter body, but is very generally like the winged type in color and general structure. The young are of a faint greenish brown, becoming darker as they grow older, until they are of the typical shining black peculiar to the full grown specimens. The antennae of the winged form have the sensory pit extremely developed, every joint beyond the basal knob joints being furnished with them. In the wingless forms the antennae have only the usual single pit on the third long joint, and the little group on the whip joint.

Life History.—This species is found on the roots of the trees throughout the year, and it breeds there quite undisturbed. Early in spring, or when the leaf-shoots begin to start, they make their way to the sur-

face and to the branches. Here the winged form develops, and then makes its way to new quarters, founding new colonies wherever it reaches, and these about midsummer make their way to the ground and to the roots. Usually some few specimens are to be found on the leaves throughout the summer, but they are much more abundant in spring.

No males of this species have been observed, and no eggs have been found.

PLUM APHIS.

Aphis prunifolia, Fitch.



Fig. 25.

This is a species of plant lice attacking the young shoots and underside of plum and prune leaves, puncturing them and sucking the sap, thereby checking the growth of the tree and the development of the fruit.

When first hatched they are of a whitish color tinged with green, but as they increase in size they become a deeper green, and when mature some of them are dark with pale green abdomens and dusky wings; eyes dark brown. The insect and infested leaves are covered with a whitish powder.

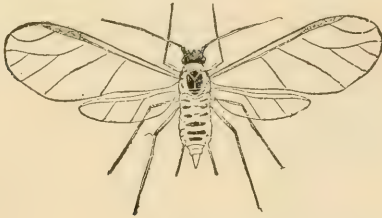
This aphis has proved exceedingly destructive in several prune-growing districts. Upon the first appearance of the lice the trees should be immediately sprayed with the rosin wash recommended for young black scale, care being taken to wet the underside of the leaves. Like all other aphis they increase enormously, and a second spraying may be necessary later on.

THE HOP APHIS.

Phorodon humuli.

Considerable alarm was occasioned in May last, amongst the hop raisers of the State, by a report that the hop louse had made its appearance in several fields in the neighborhood of Sacramento. Numerous letters and boxes containing aphis were received at this office, but none contained the true *Phorodon humuli*. The first box contained leaves of wild radish infested with cabbage lice (*Aphis brassicæ*); these were found in a hop yard. Other boxes contained the plum louse (*Aphis prunifolia*), but the only insects found upon hop vines received were the grain aphis (*Siphonophora avenæ*). These latter species were so

numerous upon the terminal growth of the hops that an extensive purchaser of Oregon and California hops, who had just returned from the Sacramento district, insisted they were identical with the louse found upon hops in Oregon. I pointed out the difference in the antennæ, also in the color of the eyes, but even then he was not satisfied, so he



Female.

Fig. 26.



Wingless Female.

wrote to one of his customers in Oregon to send him some dead specimens. Upon examining them he then became satisfied. However, I determined to visit the hop fields, and make a careful inspection, as I was informed that several thousand hop roots had been imported from Oregon the past winter. I spent two days inspecting the new fields, and also examined the older yards, but could find no trace of the *Phorodon*. It is a dangerous practice for intending planters to send to Oregon or Washington for hop roots, or even for orchardists in hop districts to send to the same States for prune or plum trees, as the eggs of the *Phorodon* can be introduced upon them.

Prof. F. L. Washburn considers that the hop crop in Oregon and Washington was injured to the extent of about one twelfth of its value, which places the loss from the hop louse, for the past season in these States, at about \$365,000, with a fair prospect of said loss being largely increased the present season.

GRAIN APHIS.

Siphonophora avenæ.



Fig. 27.

CABBAGE APHIS.

Aphis brassicæ.



Fig. 28.

The accompanying cuts illustrate the grain and cabbage louse. The difference in the *Phorodon* is in the small cornicles or horns at the base of the antennæ and in front of the head. These, together with the red eyes, can easily be seen with the aid of a good pocket lens.

CANKER, OR MEASURING, WORMS.

Anisopteryx autumnata, Packard.



Fig 29.

This is known as the fall canker worm, and was very destructive in several orchards in Santa Clara County the past season, completely defoliating apple, prune, plum, apricot, and cherry trees.

On May fifteenth I was notified of the ravages of this pest, and immediately visited the infected section, where I made a series of experiments; but the worms were then full grown; some of them had already



APRICOT.

dropped from the trees and burrowed into the loose soil, preparatory to changing to the chrysalis. The experiments on this account were not very successful, as most of the worms had finished their attacks upon the leaves. The orchardists, as soon as they found their trees were

attacked, placed tarred paper around the trunks, thinking this would prevent them climbing, but the eggs had been placed upon the branches of the trees by the wingless female moths in the fall—they generally deposit them in clusters near a bud or at the crotch of the small twigs, where they can be seen with the aid of a pocket lens. An orchardist had sprayed a portion of his apple orchard with Paris green for codlin moth, and that was in better condition than the balance.



CHERRY.

Prune, apricot, and cherry trees were so seriously infected that not a perfect leaf was left upon the trees. The accompanying illustrations show their destructive work. The young fruit also suffered, more especially the cherries and apricots. When the worms were half grown several orchardists destroyed great numbers and saved their trees from further depredations by jarring the branches with poles, or throwing dry soil over the trees with shovels; this dislodged the worms and they dropped, suspended by their webs, and were detached with a switch or pole, and by placing bands of paper upon the trunks and smearing them with printers' ink, or tar, prevented them from again ascending the trees.

Description.—The female moth (Fig. 29, *b*) is wingless and very sluggish in its movements. The body is of a uniform, shining ash color above and gray beneath, and measures from .35 to .40 of an inch in length.

The male moth (Fig. 29, *a*) is a brownish gray color and very glossy. The fore wings are crossed by two irregular white bands; the outer one is quite prominent near the apex, where a large pale spot is found. The hind wings have a distinct whitish band crossing them, as shown in the illustration. The young larvæ are of a pale olive green, changing to a darker green color, and cluster upon and eat the tender leaves. When full grown they measure about one inch in length.

Remedies.—The principal object should be to prevent the females climbing the tree in the fall. If this is properly attended to, and that portion of the trunk under the band scrubbed in the spring to destroy any eggs that have been deposited thereon, there will be no trouble from canker worms. In infected orchards where this precaution has not been taken, the trees should be thoroughly sprayed in the winter with one of the washes recommended for deciduous trees. Should any hatch in the spring the trees must be immediately sprayed with one pound of Paris green to two hundred gallons of water. This must be constantly stirred when applying, otherwise the Paris green will settle on the bottom of the tank.

FOREST TENT CATERPILLAR.

Clisiocampa sylvatica, Harris.



Fig. 30, *a*.



Fig. 30, *b*.

Although this pest is known as the forest tent caterpillar, it also attacks fruit trees. A number of apple and prune orchards suffered from the ravages of this destructive caterpillar this past spring.

The female moth (Fig. 30, *b*) deposits her eggs in circles upon the twigs or small branches; with each one is secreted a small quantity of gummy matter, which, upon drying, forms a coating and seals them to the branch and to each other. They remain in this condition all winter, and about the time the buds open in the spring the young larvæ hatch.

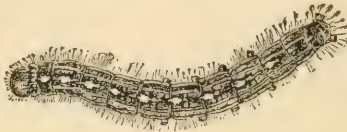


Fig. 30, *c*.

Should the leaves be backward in developing, the larvæ will exist without food for several weeks; but if food is abundant when they hatch, they will attain their full growth in five weeks, measuring one and a half inches (Fig. 30, *c*).

They are of a pale bluish color, marked with black points and dots. On the back is a row of ten or eleven oval diamond-shaped white spots, by which it may be distinguished from the common tent caterpillar; while on the sides there are pale yellowish stripes, somewhat broken and mixed with gray. The hairs on the body are fox-colored, mixed with coarser whitish hairs. Towards evening and sometimes in the morning they will collect in masses upon the large branches, when they can be destroyed. Some orchardists use a lighted torch and pass hurriedly under them when they are so located, and others use a stiff broom with which to crush them. If the entire foliage has not been destroyed, the full-grown larvæ roll themselves up in the leaves, inside of which they spin their cocoon, remaining in this state two or three weeks, when they change to the moth, and after depositing their eggs upon the twigs, as shown in Fig. 30, *a*, soon die. The moth is brownish yellow in color, with the two oblique lines across the wings dark brown.

The trees should be carefully examined in the winter, and all twigs containing egg masses cut off and burned. The cocoons should also be collected and destroyed in the summer. As soon as the eggs hatch in the spring the trees should be sprayed with Paris green, one pound to two hundred gallons of water, and the stems protected with bands to prevent the small caterpillars climbing, as they are great travelers.

IV.

BENEFICIAL INSECTS.

The value of predaceous and parasitic insects to the fruit grower has been well demonstrated by the work of the *Vedalia cardinalis*. Other species of this family (*Coccinellidæ*) are doing a great deal of good in keeping in check the hordes of destructive insects, especially those known as "scale bugs" (*Coccidæ*). Among all the beneficial insects preying upon armored scales, the diminutive internal parasites are undoubtedly of the greatest importance. Owing to the fact that they pass the greater portion of their lives under the scale, both in the larval and pupal stages, they are but little known to horticulturists. They principally belong to the Chalcid and Proctotrupid families of Hymenoptera. The female is furnished with a sharp ovipositor, which she inserts under or pierces the scale and deposits a single egg; this in time hatches into a small, blind, footless grub destroying the scale, transforms into a chrysalis, and changes into a perfect four-winged fly. All these changes are gone through under the scale, after which it cuts a small circular hole, through which it makes its escape, to afterwards produce a new generation of scale destroyers. The benefit from this class of insects is apparent in the San Gabriel Valley upon the yellow scale (*Aspidiotus citrinus*). I have recently returned from that section, where I noticed a marked decrease of scales and a great improvement in the appearance of the trees and the self-distribution of the parasite (*Coccophagus citrinus*) to new groves. The fruit from orchards in that district, and on sale in San Francisco the past season, was remarkably clean and free from scale.

COCCINELLIDÆ.

Exochomus marginipennis, Le Conte.

[Colored plate, Fig. 18.]

This ladybird resembles *Chilocorus bivulnerus* somewhat, but when examined closer differs greatly. Ground color shining black; head yellowish red; thorax with yellow margin, center black, widening on hind margin. Elytræ subconvex, shining black, with minute red spot near the center, and a large marginal spot joining the hind margin of thorax. Abdominal segments black, legs reddish brown, pubescent. Length, .16 of an inch. Found feeding upon young scale insects in Santa Clara County.

Anatis subvittata, Mulsant.

[Colored plate, Fig. 17.]

This is one of our largest ladybirds. Ground color brownish yellow, or clay color. Head with central area black. Prothorax suboval transverse; side margins broadly whitish luteous, with the whole central area black; wider on the hind margin. Elytræ brownish luteous, with two whitish spots at the base, one on either side of the scutellum, and surrounded by a black ground which forms part of the figure of its elytral ornamentation, which is that of three vittæ connected together and unequal in length and width, and rudely representing a figure 5 on each elytra. Abdominal segments brownish black; legs black. Length, .33 of an inch. Specimens of this species were sent by Mr. A. P. Campton from Humboldt County, where they destroyed great numbers of woolly aphis.

V.
INTERNAL PARASITES.

DIABROTICA PARASITE.

Celatoria crawii, Coquillett.

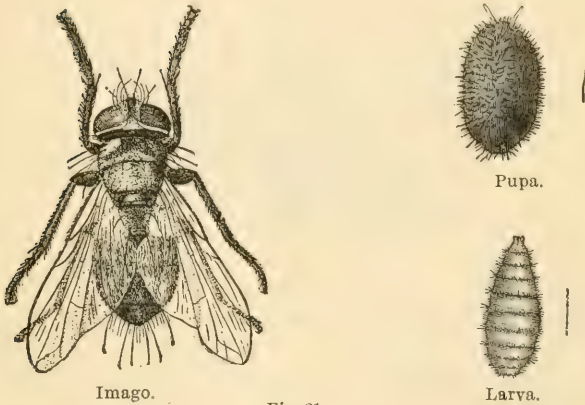


Fig. 31.

This is an internal parasite of the well known twelve-spotted squash beetle, so common in fruit-growing districts, and is one of the rare instances that have been recorded of a beetle being destroyed by the larvæ of a fly. It is not only interesting to an entomologist, but it is of great assistance to the horticulturist in reducing the numbers of such a serious pest.

I discovered this parasite in the neighborhood of Los Angeles, where I collected a large number of the beetles, and found that fully one third were parasitized. I have found them in the larval state in the beetles as early as May and as late as the middle of October. The May brood pupate early in June and remain in this condition about two weeks, when they change to the winged form. They are numerous in July and August.

I have sent colonies to different sections of the State, and hope they will become established. Mr. Ed. M. Ehrhorn, of Mountain View, Santa Clara County, informs me that he found several *Diabrotica trivittata* containing larvæ of the *Celatoria*. This is very interesting, as it shows that they will also attack the striped squash beetle.

The following description is taken from "Insect Life," Vol. II, page 235:

Male.—Frontal vitta blackish brown; sides of front white, tinged with yellow; face white; palpi reddish yellow; antennæ black. Thorax grayish black, destitute of stripes, the bristles not disposed in rows. Scutellum grayish black; abdomen black, mottled

with gray, destitute of reddish spots. Fifth segment scarcely one fourth as long as the fourth; posterior dorsal pair of bristles on the first and second segments, and a posterior transverse row of bristles on the third, fourth, and fifth segments, besides several along the sides of the abdomen. Venter concolorous with the dorsum. Legs black; claws and pulvilli much shorter than last tarsal joint. Wings hyaline. Alulae white. Halteres yellow.

Female.—Same as the male, except that there is a medium pair of bristles on the second, third, and fourth segments. Length, .18 to .22 of an inch.

Puparium.—Dark brown, cylindrical; the ends rounded; quite thickly covered with black spines of varying lengths, some of the longer ones converging and adhering to each other, forming clusters of from eight to fourteen spines. Length, .18 of an inch.

YELLOW SCALE PARASITE.

Coccophagus citrinus, Craw.



Fig. 32.

(The small cross between the antennæ indicates the natural size.)



Posterior leg.



Antennæ.

Description.—Length, .03 of an inch; wing expanse, .06 of an inch. Antennæ as long as head and thorax; color yellowish, and covered with short dark hairs; eight-jointed; scape slender and slightly curved; stout pedicel, one third length of scape; between pedicel and funicle are two very small ring joints that form the elbow; joints 3 and 4 are the shortest, 5 and 6 each increase in length and diameter; joint 7 is twice the length of 6, and 8 is the same length as 7, but narrower and tapering. Head is yellow, eyes black, ocelli bright red; posterior portion of head and pronotum are very dark brown. Thorax golden yellow; abdominal segments are dark brown, almost black. Wings are furnished with long marginal hairs; the basal half of the anterior wings are clouded, and the entire surface of the wings is covered with short hairs, with the exception of a strip commencing near the stigma and extending around the wing to nearly the opposite edge. Legs light yellow.

This preys upon *Aspidiotus citrinus*, and is the smallest internal parasite that attacks the destructive scales found in California. When at rest upon the leaf it is very difficult to detect with the naked eye, nevertheless it is proving to be one of the most valuable insects in the State. It has relieved the orange growers of the central portion of the San Gabriel Valley from the expensive necessity of annually spraying

or fumigating their trees. Several orchardists in the Los Angeles section have been inclined to abandon all work in fighting the red scale (*A. aurantii*), having heard of the benefit derived in the former district from this parasite. This is probably owing to the fact that the two species of scales have been considered identical, and both have been known by the common name "red scale;" but we have had positive evidence that the parasite will not attack *A. aurantii*, and no internal parasite has yet been found preying upon it. So, our only protection against the true red scale is to fight it with the hydrocyanic acid gas, or rosin wash.

VI.

REMEDIES—FORMULAS FOUND EFFECTIVE.

The following formulas have been thoroughly tested, and when care is taken in their preparation they will give entire satisfaction. Of course, to be successful, the condition of the weather must be considered. Should unusually heavy fogs prevail at the time of application, the work should either be deferred or a slightly stronger solution used. If the indications are for rain within forty-eight hours, the operation should be postponed until the weather becomes settled. Should a heavy shower occur immediately after spraying, that portion should again be treated, otherwise the scales will escape and infest the balance of the orchard. No spraying should be done during high winds; it is not only wasteful with the solution, but experience has proved that it is also very damaging to the trees. With thorough cooking, and a more careful observance of the atmospheric conditions, there will be less complaints of the failure of well known remedies. Another important point is thoroughness of application. With citrus trees the operator should first pass around in the inside of the tree, wetting the under side of the leaves and branches, and from the outside the nozzle should be inserted where the foliage is dense, so that every part may be moistened. With deciduous trees in winter every part can be reached; still this requires care. The nozzle should be passed between the limbs from every side, so that the spray will reach the inner surface of the opposite branches. The men doing the spraying should always be reminded of the importance of wetting every portion of the tree, and not do the work hurriedly, as has often been the case and the cause of poor results.

ROSIN WASH FOR CITRUS TREES INFESTED WITH RED SCALE.

When properly prepared this remedy will be found one of the best for use upon citrus trees, both from its effect upon the tree and as an insecticide. It assimilates perfectly with water, making a milky solution that will adhere to the foliage and wood, forming a thin, varnish-like covering that completely excludes the air from the scales, thus suffocating them. For the cottony scales (*Icerya* and *Dactylopius*) it has proved the most penetrating of all washes, sealing the eggs in a mass and thus preventing them from hatching. The following formula will be found effective:

Rosin	20 pounds.
Caustic soda (70 per cent)	6 pounds.
Fish oil	3 pounds.
Water to make 100 gallons.	

Directions for Preparing the above Wash.—Place the rosin, caustic soda, and fish oil in a large boiler, pouring over them about twenty gallons of water, and cook thoroughly over a brisk fire for at least three hours;

then add *hot* water, a little occasionally, and stir well until you have not less than fifty gallons of hot solution. Place this in the spray tank and add cold water to make the necessary amount. The great secret in the successful preparation of this wash is never to add *cold* water when cooking, otherwise the rosin will be precipitated, and it is difficult afterwards to get it in solution. This is one reason why some sprayers have had indifferent success in killing the scales with this remedy.

As far as my experience goes we have no wash that is equally effective upon the scales located upon the fruit, and this accounts for spraying being more successful on young than upon bearing trees. The oil in the rind of oranges and lemons appears to repel or prevent the wash from adhering to the fruit.

After the materials are thoroughly cooked and diluted with the proper amount of hot water, the solution should then be poured into the tank, through a very fine brass wire sieve or piece of thin open cloth. This will remove any debris that would become lodged in the nozzle, causing annoyance and delay when spraying. August and September are the best months to spray for red scales upon citrus trees.

ROSIN WASH FOR NEWLY HATCHED BLACK SCALE.

When only black scales are found upon citrus trees, the following proportions will be found effective, if applied in September or not later than the end of October. The same instructions as recommended in preparing the rosin wash for red scales should be carefully carried out in making this. It is also one of the cheapest effective washes, costing less than 1 cent per gallon:

Rosin	18 pounds.
Caustic soda (78 per cent).....	5 pounds.
Fish oil	2½ pounds.
Water to make 100 gallons.	

ROSIN WASH FOR WINTER USE UPON DECIDUOUS TREES.

The following formula will be found a very effective remedy against the pernicious scale; also for the *Lecaniums*. If for the latter species, the trees should be thoroughly sprayed as soon as the leaves drop in the fall, as then the scale is in a defenseless condition before it has formed the hard calcareous covering to its body. In some sections where a slight frost occurs early in the season, the leaves drop before the young of the "black" or "apricot scales" vacate them for the twigs. In this event, the leaves should be plowed under, as the scales at this stage of their existence still retain all their powers of locomotion, and are thus enabled to ascend and infest any tree they may chance to be near; or the leaves may be carried by the wind to other portions of the orchard not infested.

The following are the proportions of materials for the winter wash:

Rosin	30 pounds.
Caustic soda (70 per cent).....	9 pounds.
Fish oil	4½ pints.
Water to make 100 gallons.	

The directions for preparing this wash are the same as those given for citrus trees.

SUMMER WASH FOR SAN JOSÉ SCALE, FUNGUS, ETC., UPON DECIDUOUS TREES

Whale-Oil Soap and Sulphide of Potash.

Whale-oil soap (80 per cent strength)	20 pounds.
Sulphur	3 pounds.
Caustic soda (98 per cent)	1 pound.
Commercial potash	1 pound.
Water to make 100 gallons.	

Place sulphur, caustic soda, and potash together in about two gallons of water, and boil for at least one hour, or until thoroughly dissolved. Dissolve the soap by boiling in water; mix the two and boil for a short time; use the solution hot.

To accomplish the best results this wash should be used soon after the scales have hatched. From the middle of May until the beginning of July is the time when the great hatching takes place. Carefully examine the trees about that time, and after you are satisfied all are hatched apply the wash. It is very important to use a good quality of soap in the preparation of this wash. To test the soap spread five ounces of it on a tin plate and place it on top of a pot of boiling water. The loss in drying will indicate the amount of water in the soap. Thus, if one ounce is lost in drying, the soap would be of 80 per cent strength.

FOR BLACK SCALE ON OLIVE TREES.

Directions for making emulsion:

Kerosene oil (150 degrees test)	5 gallons.
Common laundry soap (or 1½ bars usually sold as pound packages)	1½ pounds.
Water	2½ gallons.

After above is emulsified, use by diluting one gallon of the mixture to six and one half gallons of water, and add two and one half pounds of home-made soap, dissolved in a little boiling water, to the solution (all the mixing is done with hot water), and apply at a temperature of 140 degrees Fahrenheit.

LIME, SULPHUR, AND SALT FOR WINTER USE UPON DECIDUOUS TREES.

For San José Scale and Lecaniums.

This remedy has been extensively used for the past three seasons, and has proved a good fungicide as well as insecticide. Mr. I. H. Thomas, of Visalia, the gentleman who brought it prominently before the public, uses thirty pounds of lime, and considers this enough; but better results have been obtained in the coast counties by adding more lime. The recommendation to thoroughly cook the rosin wash applies equally to this. Some experiments have been made to find out which of the materials is the insecticide, but it cannot be claimed for either separately, but to the combination, and upon this account they should be well boiled.

The following formula and directions, if properly carried out, will produce an effective solution:

Unslacked lime	40 pounds.
Sulphur	20 pounds.
Stock salt	15 pounds.
Water to make 60 gallons.	

Directions.—Place ten pounds of lime and twenty pounds of sulphur in a boiler with twenty gallons of water, and boil over a brisk fire for not less than one hour and a half, or until the sulphur is thoroughly dissolved. When this takes place the mixture will be of an amber color. Next place in a cask thirty pounds of unslacked lime, pouring over it enough hot water to thoroughly slacken it, and while it is yet hot and boiling add the fifteen pounds of salt. When this is dissolved add to the lime and sulphur in the boiler and cook for half an hour longer, when the necessary amount of water to make the sixty gallons should be added. The solution should then be strained through a brass strainer or a piece of burlap. When using it should be frequently and well stirred. In applying this wash a spray nozzle having a rubber orifice or plate should be used, as those made of brass are soon worn out by the action of the lime.

GAS TREATMENT.

This method is a Californian invention, and has proved the most successful of any remedy for destroying scale insects, especially upon citrus trees, as owing to their dense foliage and the difficulty of killing the insects located upon the fruit, spraying has not been altogether successful. With a tent covering the tree, and the proper amount of gas, portions of it are not missed, as is frequently the case in spraying.

The derricks and tents required are more expensive than a spraying outfit, but the result is more lasting. An orchard that has been properly fumigated, and not in the immediate vicinity of infested trees, will remain clean for at least two years. This would justify the extra first cost of an apparatus. In order to have satisfactory results from fumigation, it is necessary to procure the best grade of fused cyanide of potassium. That prepared by Powers & Weightman, of Philadelphia, Pennsylvania, has given entire satisfaction; it contains about 60 per cent cyanide. An analysis should always be demanded in purchasing large quantities. Samples should also be submitted to a competent chemist, for the operator should know beyond a question the strength of his material. Another important matter is to see that the workmen can accurately estimate the height and diameter of a tree. The necessity of this will be evident after a number of men note down their estimates of a certain tree, and then make measurements.

The use of a light pole, with the number of feet marked thereon, and a few experiments with it by the beginner, will tend to more uniform results. The mistake of even one foot in the diameter of an average sized fruit tree will be sufficient to reduce the density of the gas so that the operation would be a failure. To remedy this, it is advisable to allow the tent to remain over the tree not less than forty minutes. This will give ample time for the gas to become diffused, and the lengthened exposure will have the desired effect upon the insects.

If three derricks are used, each provided with two tents, the work can be carried on by three men without loss of time. With four planks to each wagon to prevent the wheels sinking in the soft cultivated soil, the horses can be dispensed with, unless in moving the apparatus from one grove to another. Better results have been obtained, and the trees are less liable to injury from scorching, when the light has been excluded by a darkened tent (painted black), or treated at night. The reason

advanced for this is, that the sunlight decomposes the gas, changing to other gases injurious to the tree.

The amount of cyanide of potassium (58 per cent) required for the different sized trees will be found in the following table:

Height of Tree—Feet.	Diameter Through Foliage—Feet.	Water—Fluid Ounces.	Sulphuric Acid—Fluid Ounces.	Cyanide of Potassium—Ounces.
6	4	2	1	1
8	6	4	2	2
10	8	6	3	3
12	10	10	5	5
12	14	14	7	7
14	14	16	8	8
16	16	18	9	9
18	16	20	10	10
20	16	22	11	11
22	18	24	12	12
24	20	26	13	13
26	20	27	13½	13½
30	20	28	14	14

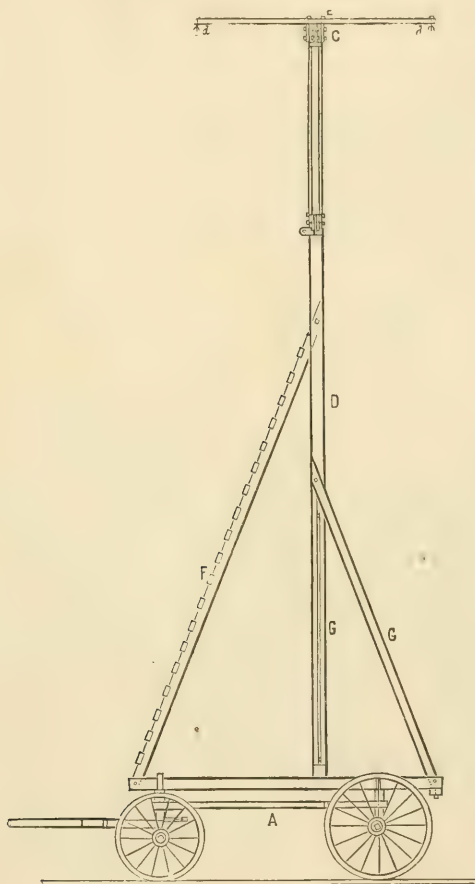
In August last I visited Riverside, and in company with Dr. N. H. Claffin, Horticultural Commissioner for that district, made a careful inspection of the two groves that have been recently fumigated for *A. aurantii*. Upon examination I found that the gasing had been very successful in killing the scales without injury to any but the smaller trees, the tops of which, in one of the groves, were slightly damaged. This part of the grove was treated by the owner with the assistance of one of his men, and in their determination to kill the scales more chemicals were used than were necessary.

The example of the city of Riverside can be followed with advantage in other fruit-growing districts, in furnishing to the orchardist fumigating apparatus for a small rental—sufficient to pay for the wear and tear. The city receives the benefit in saving her productive and beautiful groves, and the fruit grower is saved the heavy expenditure of providing a private outfit. The only expense is for operating and necessary chemicals. Another advantage is that the operators are thoroughly trained, and the work can be done more expeditiously and economically than if undertaken by the orchardists. The fumigation at Riverside is in charge of Mr. T. B. Johnson, who attends personally to the proportions of chemicals necessary for each tree, and from his experiments upon large trees he has shown that the amount required is much less than was formerly considered requisite.

The city owns three derricks, one of which is shown in the accompanying illustration, and is Dr. Claffin's improvement of the Preble fumigator. The mast is extensible nine feet, and is also pivoted ten and a half feet from the ground, so it can be lowered to pass under the telegraph wires in moving to another grove. The main yard is hinged at the mast so that either or both arms can be dropped parallel with the mast. The latter is placed behind the rear axle of the wagon, and thus prevents the ropes from getting under the wheels. The wagon-bed is narrower in front, so that the forward wheels can be drawn well around for turning short.

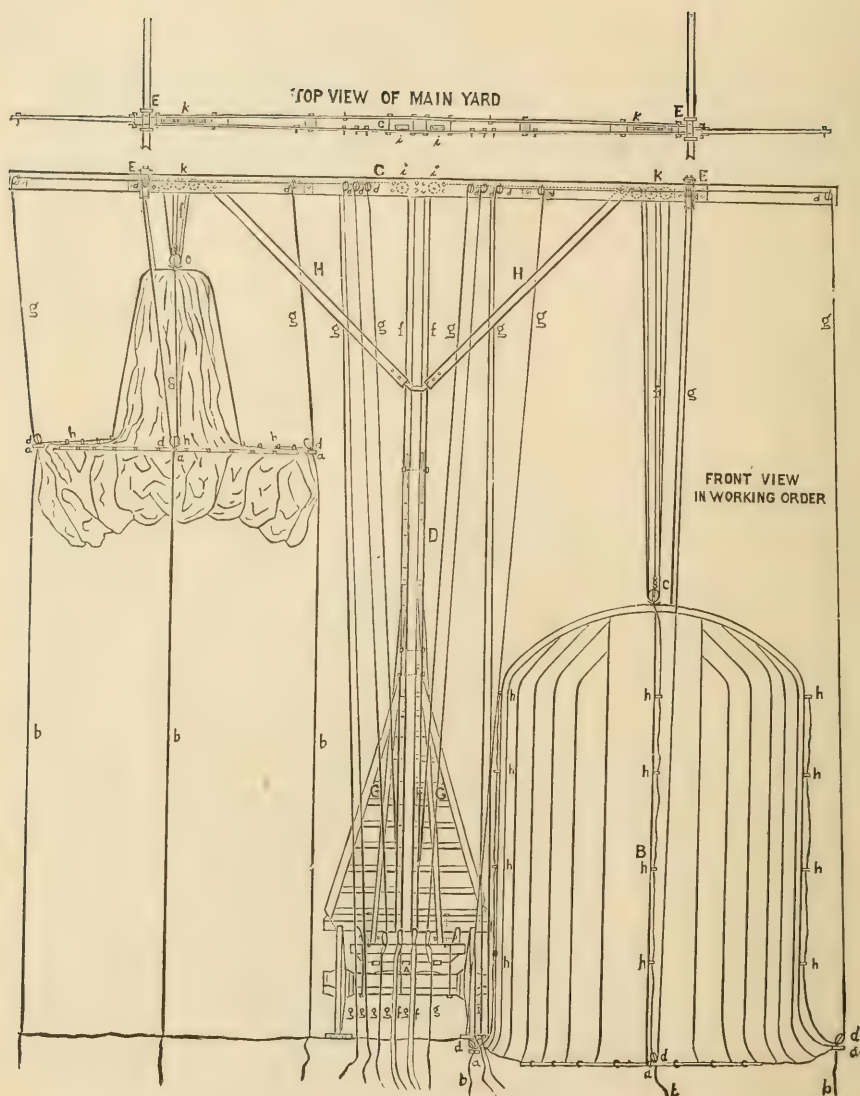
PLANS OF FUMIGATING APPARATUS.

For the benefit of any one desiring to construct a fumigating outfit, I append the plans of the apparatus constructed by S. W. Preble, Esq., of Tustin, Orange County, taken from the Annual Report of the State Board of Horticulture of 1890, the entire edition of which is exhausted. There is no patent upon this invention, and any one is at liberty to adopt it:



SIDE VIEW OF FRAME.

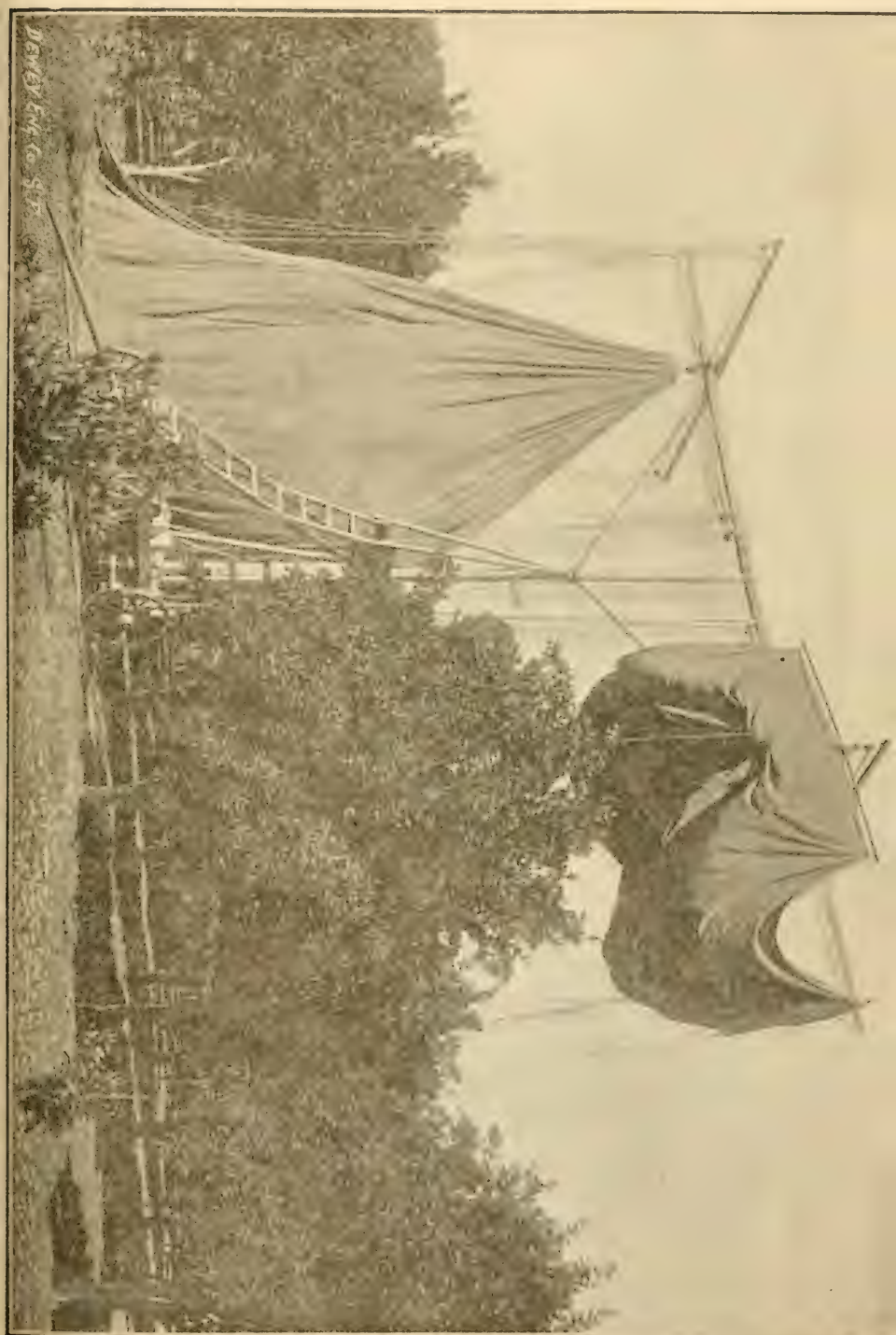
Description.—A. Wagon. B. Tents (2). C. Main yard. D. Mast. E. Crossbars (2). F. Ladder. G. Mast stays (6). H. Main yard truss (2). a. Trail boards (8), to bottom edge of tents. b. Guide lines (8), one half inch diameter to trail boards, thirty feet each. c. Six-inch blocks (2), double sheave, for hoisting tents. d. Four-inch blocks (20), single sheave, for hoisting trail boards. e. Belaying pins (4), galvanized iron, to fasten ropes. f. Main rope (2), three quarters inch diameter, for hoisting tents, one hundred and ninety feet each. g. Trail ropes

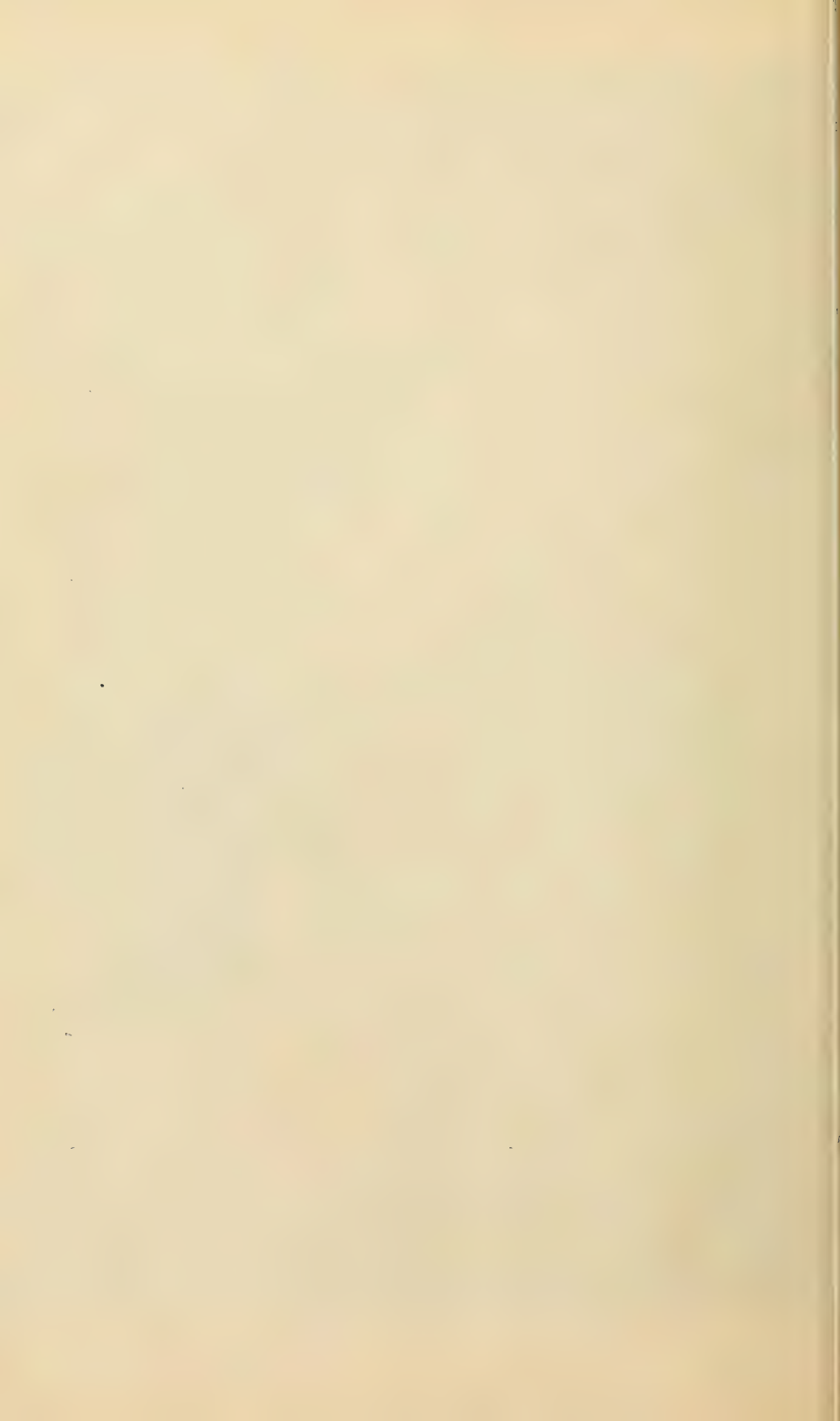


FRONT VIEW IN WORKING ORDER.

Scale: One eighth of an inch to the foot.

(8), for hoisting sides of tents, one half inch diameter, one hundred and twenty feet each. *h*. Rope thimbles (32), one half inch diameter, galvanized iron, for trail ropes of tents. *i*. Six-inch sheaves (2), brass, in main yard, for hoisting tents. *k*. Five-inch sheaves (6), brass, in main yard, for hoisting tents.





VII. SPRAYING APPARATUS.

PUMPS.

The spread of injurious insect pests in the past few years has caused the invention and improvement of a great many spraying apparatus. The following are the most approved pumps used in the State:



Fig. 33.



Fig. 34.

The Climax No. 1* (Fig. 33) is a very neat machine. It is used a great deal by small growers. It consists of a tank made of heavy galvanized iron, is oval in shape, and will hold eight gallons of liquid. It is provided with a handle for convenience in carrying, and on the reverse side is a notch for placing the foot for the purpose of holding it down while in use. In this tank is securely fitted a double action pump, made entirely of brass. A fine copper strainer at the bottom prevents sediments from passing up and choking the spray nozzle. The hollow piston rod, combined with the check valve at the bottom of the cylinder, makes a strong, steady flow, the air in the hollow piston acting as a cushion. Owing to the great lifting and forcing power obtained, the pumping movement is very slow. The different parts of the pump being brass, there is nothing to corrode by the use of strong washes.



Fig. 35.

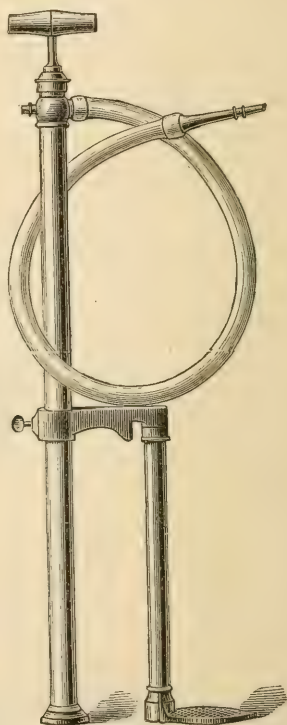


Fig. 36.

The Fountain pump, or Hydronette† (Fig. 34), is also a very good apparatus, and can be used for various purposes. It is especially good for spraying trees infested with insect pests in close quarters. This pump is made of brass with a rubber hose attached for suction. The pump has two brass cylinders fitting one into the other, and works on the principle of a syringe. Mr. A. Block, the extensive orchardist of

* R. S. Chapman, 18 California Street, San Francisco.

† Woodin & Little, 312 Market Street, San Francisco; Holbrook, Merrill & Stetson, San Francisco.



Fig. 37.

Santa Clara, has a number of these in use and prefers them to large pumps. Figs. 35,* 36,* and 37* are also excellent small pumps.

A very convenient apparatus for those who have but a few trees infested is the Excelsior Knapsack sprayer† (Fig. 37½).

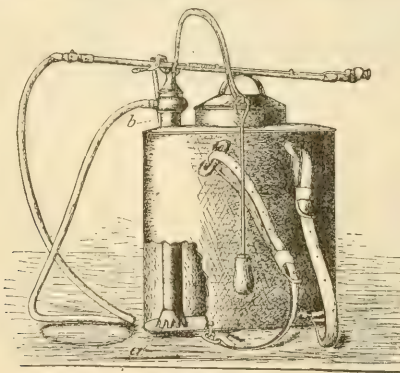


Fig. 37½.

It can be fastened to a person's back and carried from one tree to another. It is made of copper, and the pump works very easily. Occasionally a tree or two will be found infested by some pest or other, and will, if not promptly attended to, spread to other trees. This can be prevented by using the above pump, and without much loss of time. Although using the above pumps on a small scale as stated, when but a few trees are infested, the proper way is to wash the entire orchard, as insect pests spread very quickly, and trees appearing free from them may have a few, which will increase to such an extent as to cover the trees in one season.

*Woodin & Little, 312 Market Street, San Francisco.

†Albinson & Co., 206 Fourteenth Street, Washington, D. C.; Leitch & Sons, 1214 D Street, Washington, D. C.

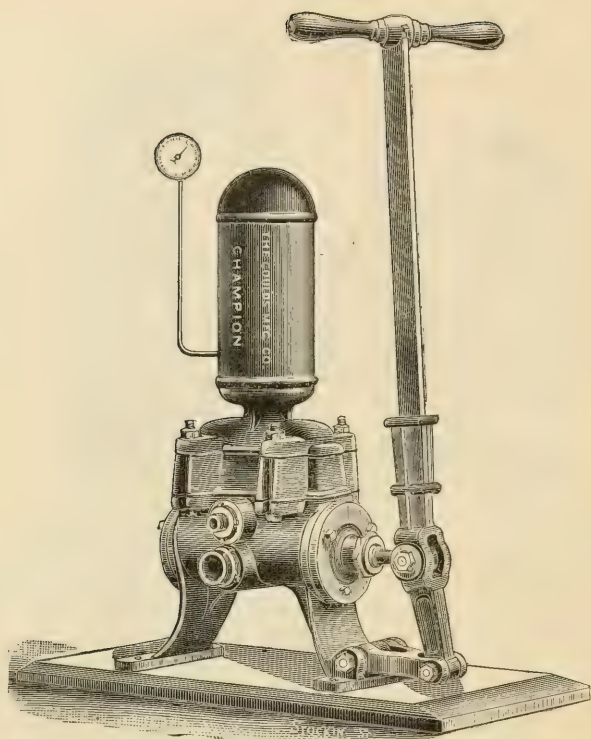


Fig. 38.

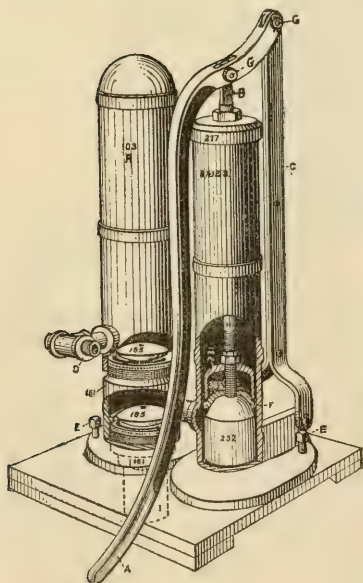


Fig. 39.

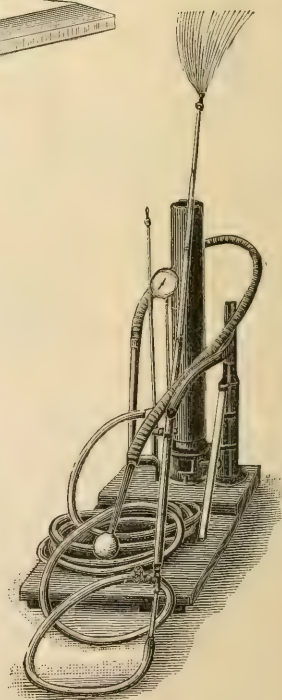


Fig. 40.

We will now turn our attention to the larger spray pumps. These pumps are mostly used by the extensive fruit growers of the State. The Champion spray pump* (Fig. 38) is a very strong and compact pump, has double action, and the cylinder is lined with brass. The motion of the piston is horizontal, and the handle is so arranged that no bending is required. The pump has a good air chamber, which gives a continuous and even discharge. The valves are metal and lie directly beneath the air chamber, being easily reached when out of order. The plunger is a solid disk of vulcanized rubber, and is made so that the wear may be instantly taken up by tightening a nut. A gauge can be attached to the pump. This is a very good idea, as when testing the pump on the first trip a certain pressure will show where the pump works best, and the man at the handle can always keep it at such pressure, thereby making the spraying uniform.

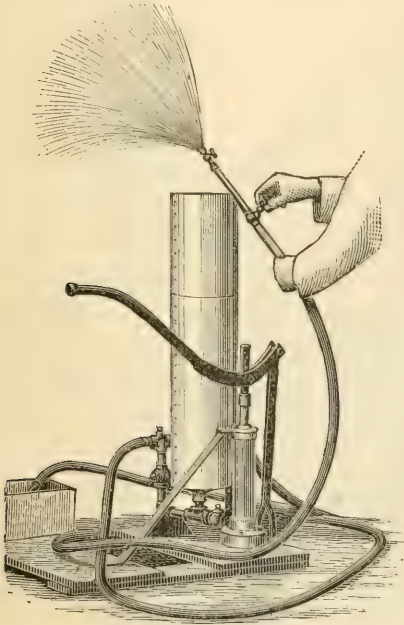


Fig. 41.

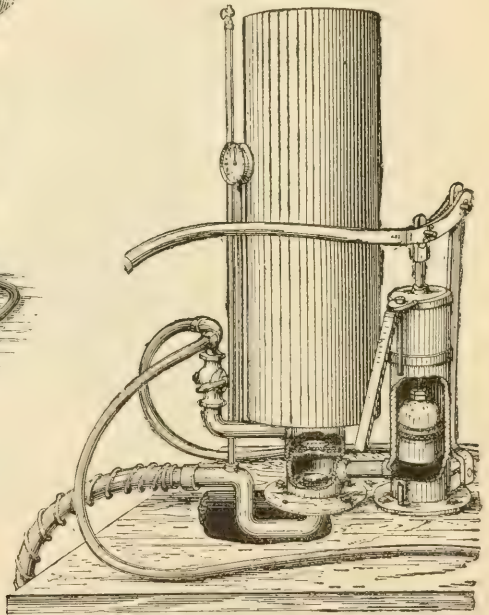


Fig. 42.

The Bean spray pumps† (Figs. 39, 40, 41, and 42) are used very much throughout the State, and have proved very reliable pumps. The main feature of this pump is the charge receptacle. This is a cylinder,

*Woodin & Little, 312 Market Street, San Francisco.

†Bean Spray Pump Company, Los Gatos, Cal.

made of strong sheet iron, and holds about five gallons of wash. It will, when properly charged with air and fluid, throw a continuous spray from ten to fifteen minutes without operating the handle. It is best to charge with air first and then with fluid. A gauge shows the quantity. About fifty pounds pressure per square inch of air, the balance fluid, and kept at one hundred pounds pressure, will do good work.

The cylinders in the Bean spray pump are enameled inside. This will withstand the action of the acids or alkali in the solution; and the valves and plunger packing are made of a rubber compound that is chemically prepared to resist the action of corrosive washes. The valves of the latest improved Bean spray pumps are easily reached; nothing but a common wrench is necessary and no mechanical skill required to change the valve or plunger packing. The pump shown at Fig. 42 can have four lines of hose attached.



Fig. 43.

Another good pump is the Improved Climax No. 2* (Fig. 43). It is mounted on a fifty-gallon barrel, and has two brass pumps like Climax No. 1, but larger and more powerful. Each of these pumps is complete in itself, but the two are connected by a crosshead at the top and are worked by the same stroke. The two pumps are joined and empty into a **A**-shaped

*R. S. Chapman, 18 California Street, San Francisco.

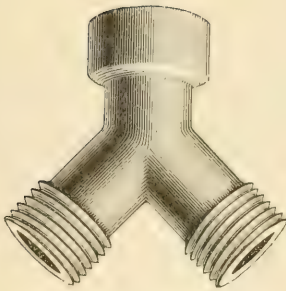


Fig. 44.

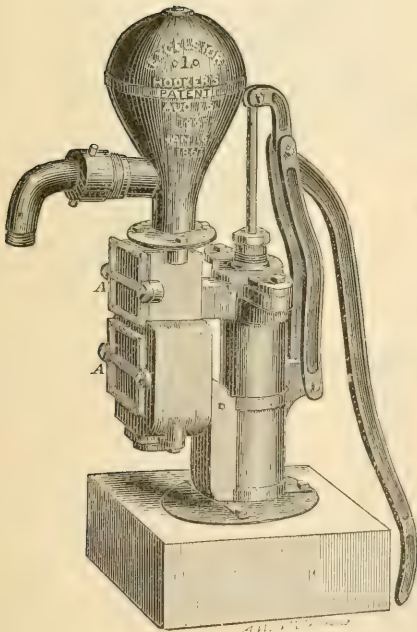


Fig. 45.

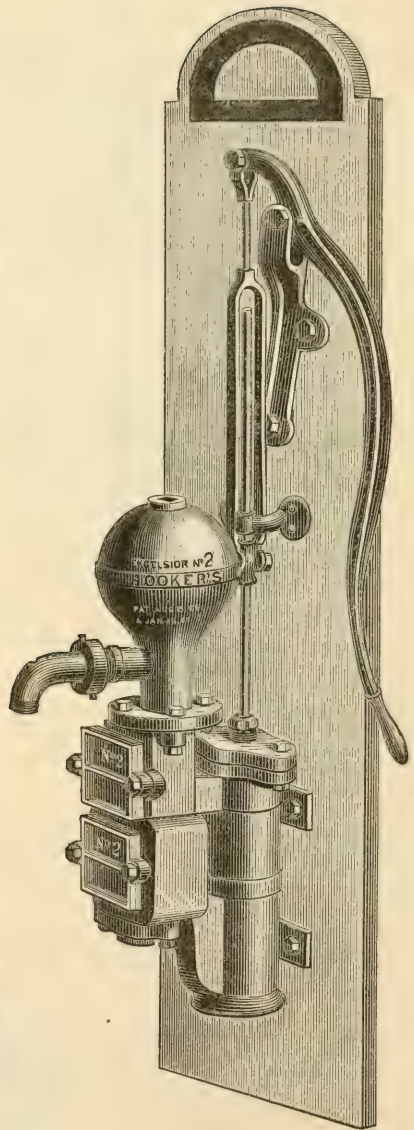


Fig. 46.

coupling (Fig. 44), allowing two lines of hose to be attached. A very important addition to this coupling is a stopcock attached to each branch of the **A**, permitting the current of each hose to be shut off separately. Like the small Climax, this one has hollow piston rods, and besides has an air chamber which insures a strong continuous flow. Each pump has a copper strainer at the bottom. Everything in this pump is brass. The pistons are also brass, and are fitted with water rings, and therefore do not require packing or readjusting.

The Excelsior Improved Double-Acting, Hooker's Patent* (Fig. 45), is a strong, durable pump, and a favorite in the southern part of the State, where it is extensively used in the orange groves, and has given great satisfaction. Fig. 45 can be fastened on top of the tank and Fig. 46 can be bolted to the side, but the former is the preferable style. The valves of these pumps are very simple and durable, and easily accessible. They can be changed without disconnecting air chamber, suction or discharge pipes. Fig. 45 shows the place where the valves can be reached.

The Manhattan brass spraying pump* (Figs. 47 and 48) is extensively used in Napa and Sonoma Counties. This pump has rubber valves, which can easily be replaced.

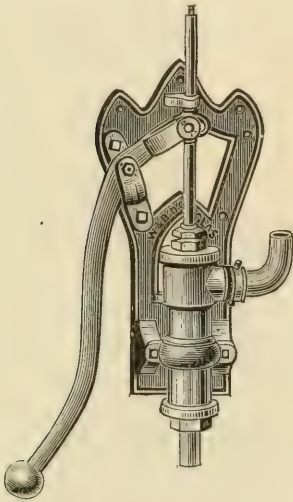


Fig. 47.

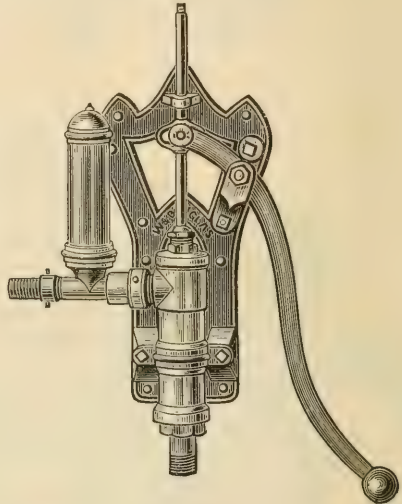


Fig. 48.

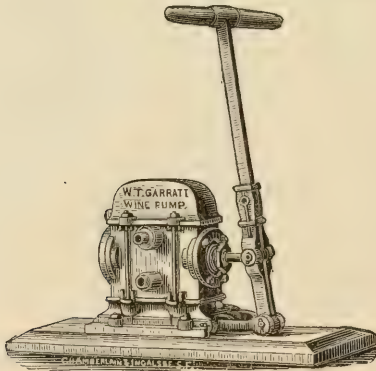


Fig. 49.

Garratt's Horizontal Spray or Wine pump† (Fig. 49) is a double-acting, compact, and durable one. The valves are easy of access, so that little trouble or loss of time is caused when repairs become necessary. A

* Holbrook, Merrill & Stetson, San Francisco, Cal.

† W. T. Garratt & Co., San Francisco.



Fig. 50.

good illustration of the pump at work will be seen in Fig. 50. It can be placed on a sled or can also be arranged on a wagon, as desired.

NOZZLES.

According to the different materials for spraying trees, different styles of nozzles are used to do the work. The lime, salt, and sulphur wash

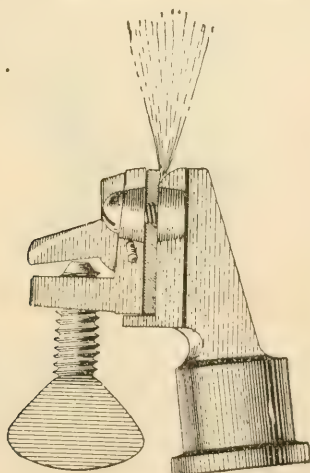


Fig. 51.

has gained a strong foothold as a winter wash, and the "Duck's Bill," or new Bean nozzle (Fig. 51), was manufactured by the Bean Pump Company to answer the purpose.

The above wash always carries some coarse materials with it which wear out a metal nozzle in a few hours, the wash acting like a file on the fine edges. The new Bean nozzle is furnished with a rubber plate, against which the liquid strikes. This rubber can be used several times by turning it, and is also easily replaced. As will be noticed in the cut, the nozzle has a thumbscrew for making a fine or coarse spray. The orange growers of the State object to the protruding parts of all nozzles, as it is very difficult to prevent the small limbs catching therein. They prefer such nozzles as the San José (Fig. 52) and the Imperial (Fig. 57).

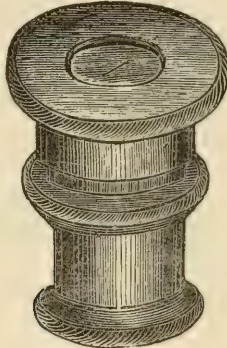


Fig. 52.

The San José nozzle (Fig. 52) can be used for the lime, salt, and sulphur wash. A rubber disk is used and does very fine work. For caustic washes or kerosene emulsion, a brass disk is placed instead of the rubber. Recently an improvement has been made for cleaning this

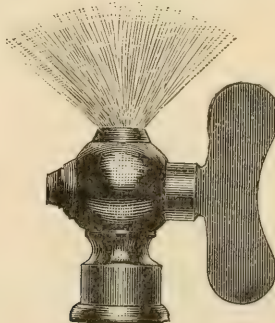


Fig. 53.

nozzle. It consists of a sliding disk in which are several slits and a circular hole. If, when using a fine spray, it should clog, slide the disk over to the hole, when the coarse stream will remove the obstruction.

The Bean nozzle (Fig. 53) is a very handy nozzle, and is well made. It has a coarse as well as a fine adjustment, and can be easily cleaned.

The stopcock has three different cuts, and when the fine spray gets clogged, by simply turning to the opening it will carry off the obstacle and clean the nozzle.

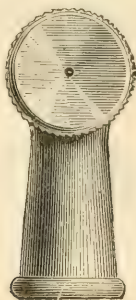


Fig. 54.

The Cyclone nozzle (Fig. 54) gives a very fine spray and has no projection, and therefore does not catch in the fine branches of trees. The spray can be thrown straight up the tree or in a shower from above, or can be turned so as to wash the underside of the leaves. The cap can be removed when necessary to clean the nozzle. An improvement has recently been made on the cap. Instead of having a dented edge the cap is hexagon, and a small pocket wrench can be used to loosen the cap, as the old style is sometimes very difficult to unscrew.

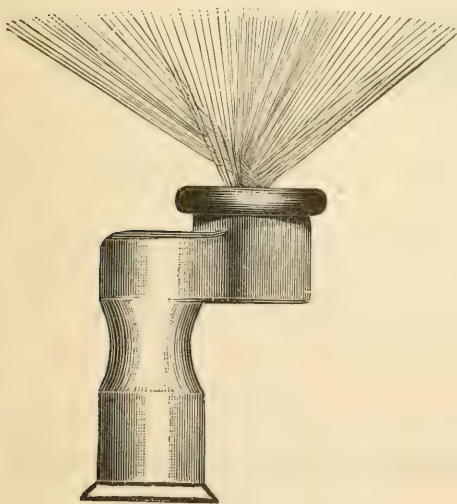


Fig. 55.

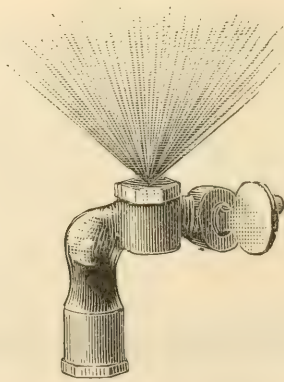


Fig. 56.

The Pacific Cyclone (Fig. 55) and Chapman's Cyclone (Fig. 56) are about the same as Fig. 54, only having the spray discharge direct, instead of to one side. Chapman's nozzle has a cleaning device, but it forms that objectionable hook; otherwise it works very well.

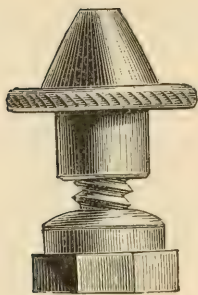


Fig. 57.

The Imperial nozzle (Fig. 57) is greatly used on the Sacramento River. As before stated, it is one of the plain kind, and can furnish a fine and a coarse spray.

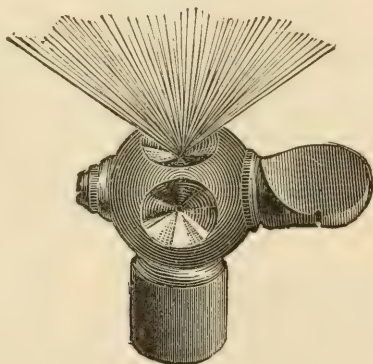


Fig. 58.

Green's End and Side Spray (Fig. 58) is a very solid piece of mechanism. It resembles the Bean nozzle very much, but has two distinct outlets, and also a separate circular cleaning hole.

It is very hard to recommend any nozzle in preference to another; they each have good points, and fruit growers should choose according to the materials and the class of the trees they intend spraying.

EXTENSION RODS.

Bamboo Extension.

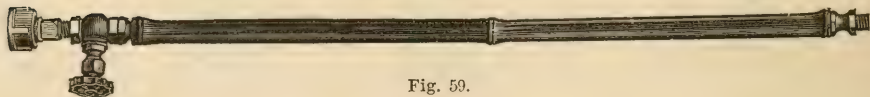


Fig. 59.

After trees attain a certain height it is very difficult to reach every point of the tree without the aid of an extension rod. These rods vary in length from five to twelve feet. The material used is $\frac{1}{2}$, $\frac{3}{8}$, and $\frac{1}{4}$ -inch gas pipe, which makes a strong and light rod. At the base of these rods is a stopcock, which is used to turn on and shut off the spray when necessary to clean the nozzle. The bamboo has been utilized for rods

and at Fig. 59 is a bamboo extension, through the center of which passes a thin brass pipe. These are, of course, very light, and are used very much, but are not as durable as the gas pipe.

SPRAYING HOSE.

Good rubber hose is one of the most important articles in a spraying outfit. The pressure of the pumps will, in every instance, swell a poor hose to double its diameter. It is therefore necessary in the start to purchase a good quality, and the most desirable size to use is the half-inch four-ply rubber hose. The sections should not be less than fifty feet, as with this length the operator can pass around the tree and thoroughly spray every portion before leaving it.

SPRAY TANKS.



Fig. 60.

A fifty-gallon barrel with a square piece (eight by ten inches) sawed out of the head, beveled so as to prevent it dropping in, and fixed with a pair of brass hinges, makes a good tank, where only one line of hose is used. The pump, when practicable, should be bolted to the head of the barrel. With other styles of pumps a nipple near the bottom should be placed, to which the suction hose can be attached. This outfit can be carried upon a sled, drawn by one horse. But where considerable spraying has to be done, a tank holding from two hundred to two hundred and fifty gallons should be constructed and mounted upon a farm wagon having broad tires. The material should be well seasoned, one and one half inches thick. All the joints should be water-stopped, *i. e.*, grooved, into which is fitted a long slat. This will prevent leakage from strain or shrinkage. The tank should be bolted together with long iron bands; one end of each should be provided with screw and nut, so that it can be tightened. Upon the top and to one end should be a hopper, with the sides beveled, and eight inches high, and wide enough to admit the entrance of a man if necessary. Into this hopper a movable box, with a brass-wire screen bottom, should be fitted, through

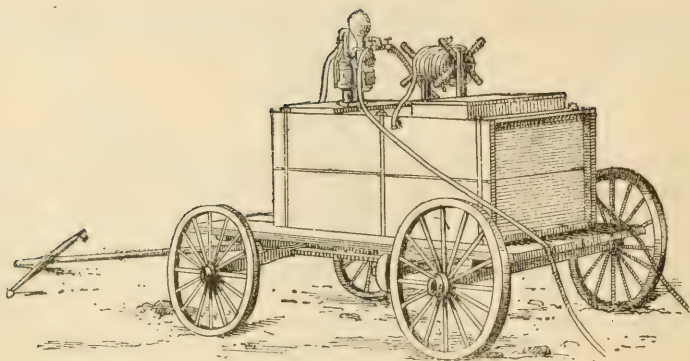


Fig. 61.

which all the solution should be strained. Over this a hinged cover keeps the box in place, and prevents leaves or rubbish, passing into the tank and clogging the nozzles. Upon the bottom, or in one end, should be a two-inch hole, for the purpose of cleaning the tank. Some spray tanks are provided with divisions, each connected with pipe and stop-cock, for sidehill orchards. This equalizes the load upon the wheels, and is a great improvement.

BELLOWS AND SIFTERS.

In some instances, when trees, shrubs, and flowers are attacked by insects, the materials for disinfection are used in a powdered state. To spread these evenly over the infested plants, various apparatus have been invented.

Among the most primitive is a common preserve can with a piece of wire cloth soldered in the bottom. The fineness of the wire cloth will not permit a great quantity of material to sift through at one time, and in that way will cover the shrub with a very even coat. For high trees the can is fastened to a long pole, and by shaking the pole the substance will sift over the tree.

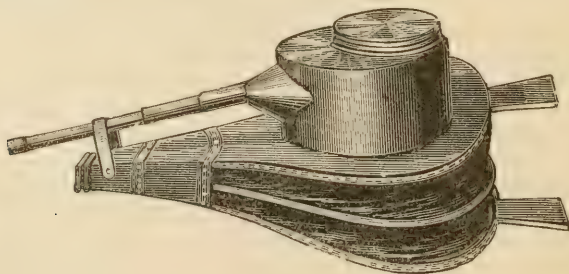


Fig. 62.

The Favorite* (Fig. 62) is an improved sulphur bellows. This is no doubt the simplest and best bellows made, and is constructed in such a way that the operator can only expel just enough material without

* California Bellows Co., 123, Beale Street, San Francisco.

excess, thereby saving a large percentage. When operated, having no elbows or projections, it will not catch in limbs of plants. The long tube, as seen in the cut, prevents the operator from endangering his eyesight. The receptacle on top of the bellows is filled with the material to be used. A tube passes from the bellows through the substance to the lid. This tube has a cap which has four long holes cut into it, and is kept on the tube by a little brass spring. When forcing air through the tube it lifts the cap up to the holes and forces the powdered material out of the discharge tube.

DEALERS IN SPRAYING APPARATUS.

Not having received the names of all the dealers in spraying outfits, our list is not a complete one, and parties desiring pumps or spraying outfits can procure them through their local dealers. The following are a few in the principal towns of the State who can be addressed in regard to pumps and spraying apparatus:

Harper, Reynolds & Co., Los Angeles.
W. C. Furrey, Los Angeles.
Brown & Foster, Los Angeles.
F. W. Baker, Ventura.
P. Charlebois & Co., Ventura.
Bryant Bros., San Diego.
Harville Bros. & Co., San Diego.
M. J. Bundy, Santa Ana.
Drake & Clark, Santa Ana.
L. Gildmacher, Santa Ana.
J. S. Haywood & Co., Santa Ana.
John McFadden, Santa Ana.
S. W. Luitweiler, Riverside.
A'Fleck & Ormand, Riverside.
Trowbridge & Wakeman, Riverside.
James G. Burt, San Bernardino.
Geo. M. Cooley, San Bernardino.
Edwards & Co., Santa Barbara.
Nixon & Boseka, Santa Barbara.
Dinkelspiel Bros., Bakersfield.
A. Weill, Bakersfield.
A. Williamson, San Luis Obispo.
F. W. Vetterline, San Luis Obispo.
Wood Bros., Visalia.
Sweet & Co., Visalia.
Barrett, Hicks & Co., Fresno.
Donahoe, Emmons & Co., Fresno.
Vanderhurst, Sanborn & Co., Salinas.
J. A. Webster, Salinas.
Wm. Palmtag, Hollister.
Henry Snibley, Hollister.
Parker & Robinson, Santa Cruz.

J. H. Heath, Santa Cruz.
Farmers Union, San José.
Mangrym & Otter, San José.
The John Stock Sons, San José.
Montague & Co., San José.
J. F. Archibald, Merced.
R. Bancroft, Merced.
Huddleson & Co., Modesto.
Jamison & Reedy, Modesto.
T. G. McNamara, Redwood City.
H. Schwarz, Napa City.
James & Son, Napa City.
J. C. Mailer, Santa Rosa.
Burch & Mathews, Santa Rosa.
F. A. Ruhl, Stockton.
John Jackson, Stockton.
Baker & Hamilton, Sacramento.
Kilgore & Co., Sacramento.
Weatherwax & Morey, Placerville.
J. M. White, Auburn.
Hampton Hardware Co., Marysville.
White, Cooley & Cutts, Marysville.
Jas. C. Gray, Oroville.
Oroville Hardware Co., Oroville.
J. H. Barker, Ukiah.
F. Brunner, Sr., Ukiah.
A. M. Newland, Colusa.
J. Grier, Colusa.
Cone & Kimball Co., Red Bluff.
Morris & Campbell, Red Bluff.
W. H. Johnston, Eureka.
H. H. Buhne & Co., Eureka.

LIBRARY OF CONGRESS



0 000 884 541 4